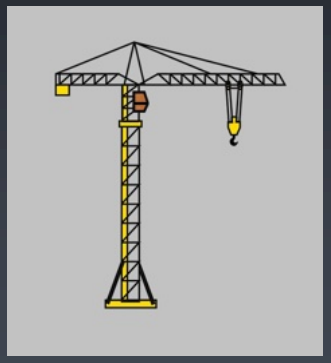
The Equine Digit: Structure, Function, and The Physical Exam

Andrew Parks
University of Georgia College of Veterinary Medicine

The Equine Digit as a Mechanical System



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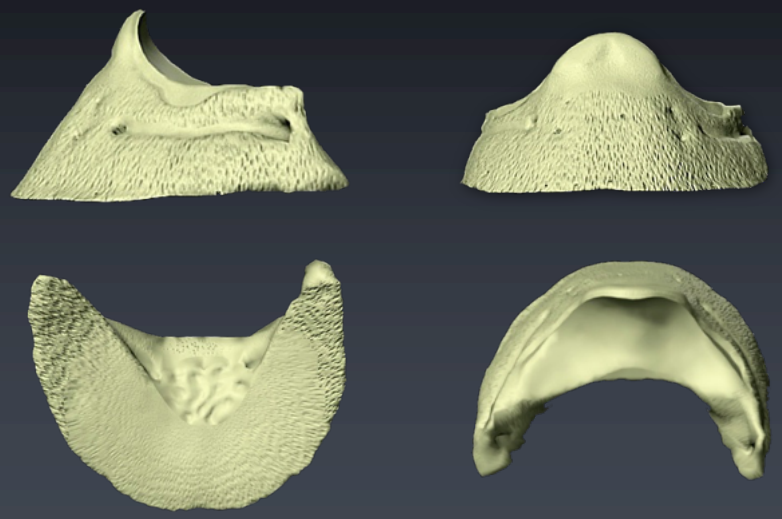
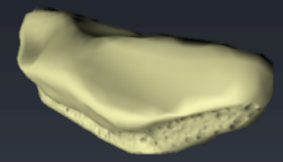
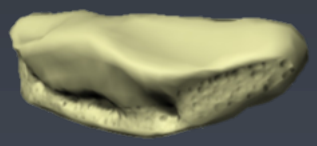
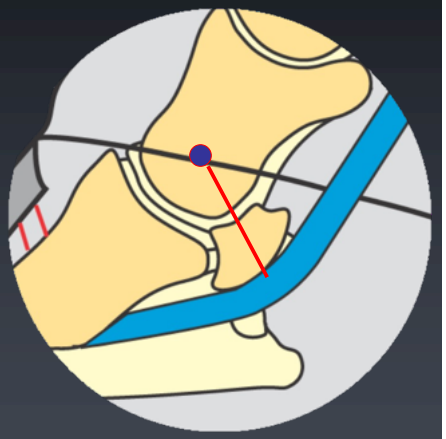
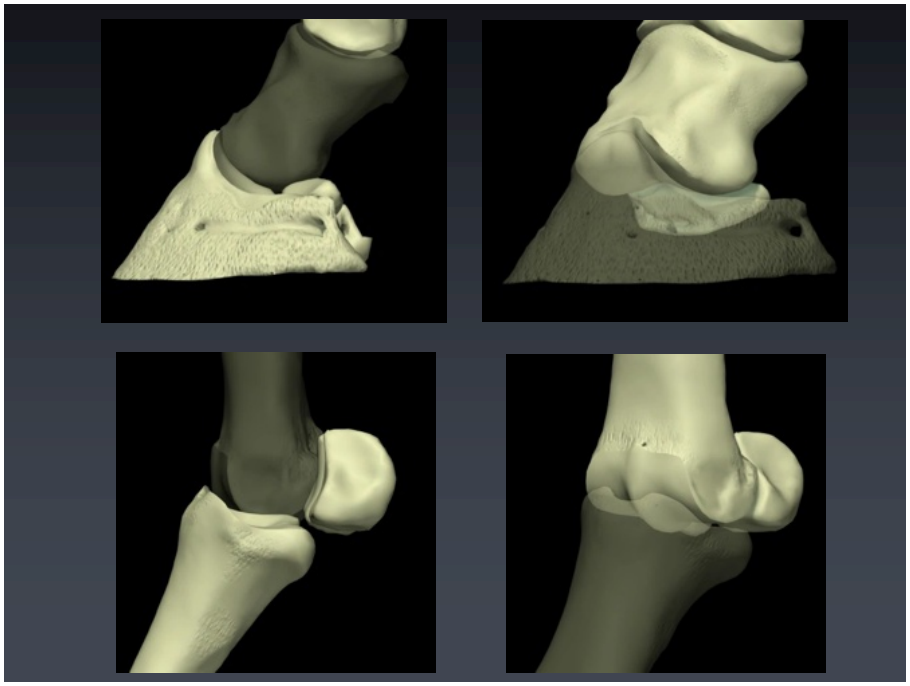
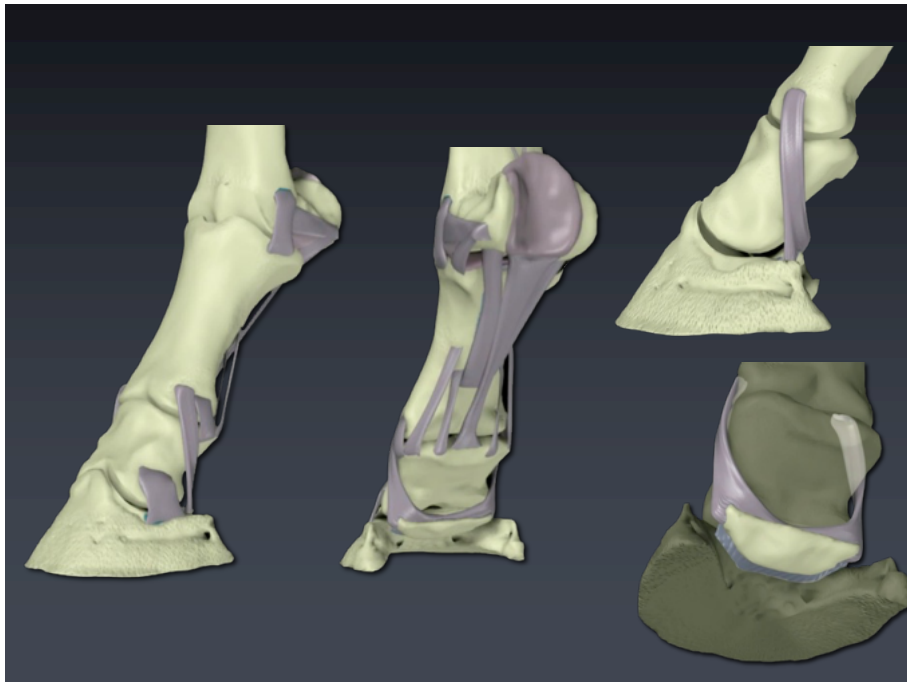


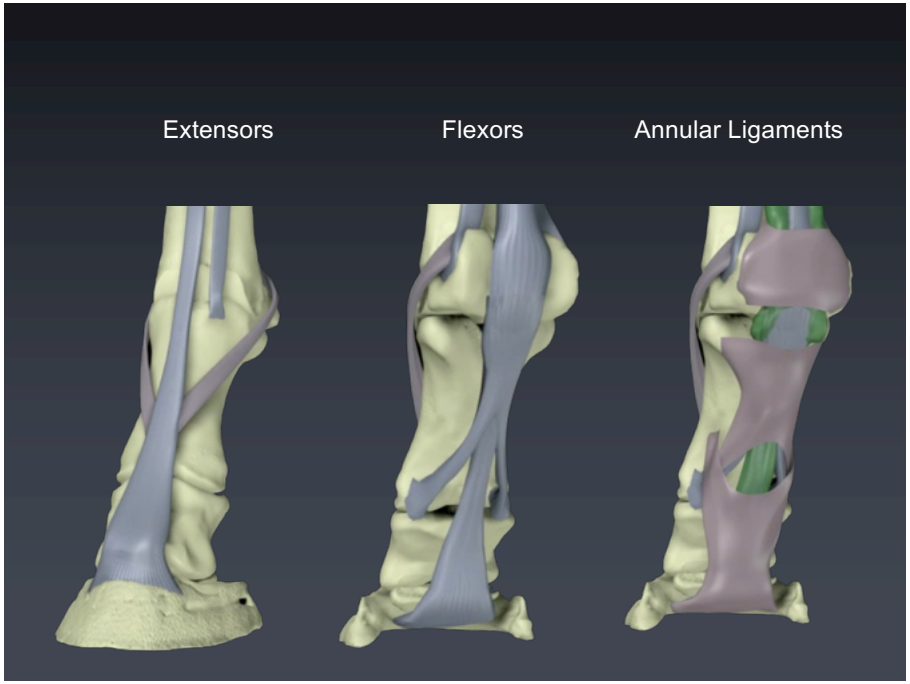


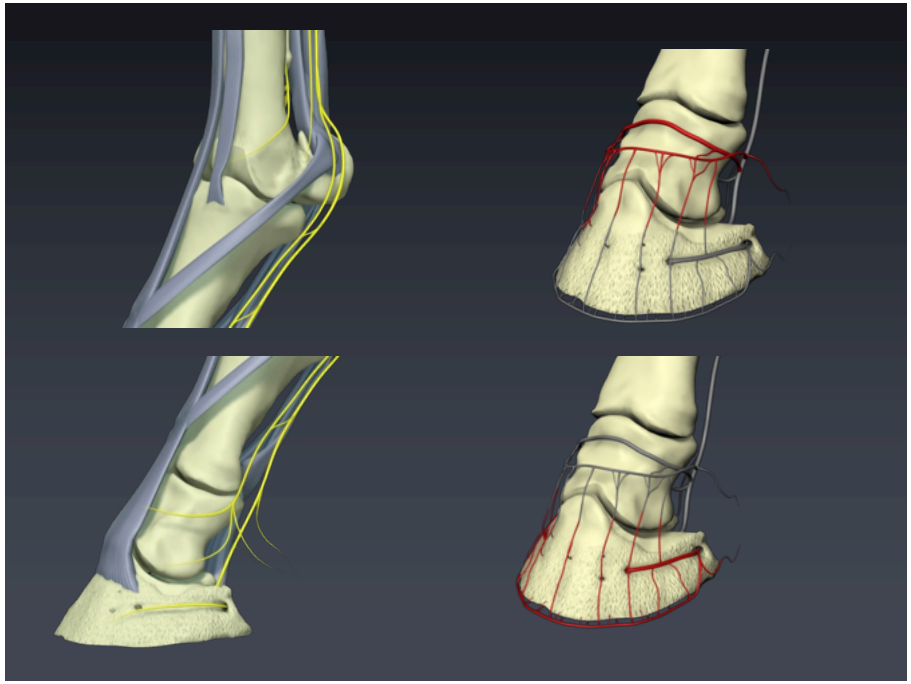









Extensors
Flexors
Annular Ligaments



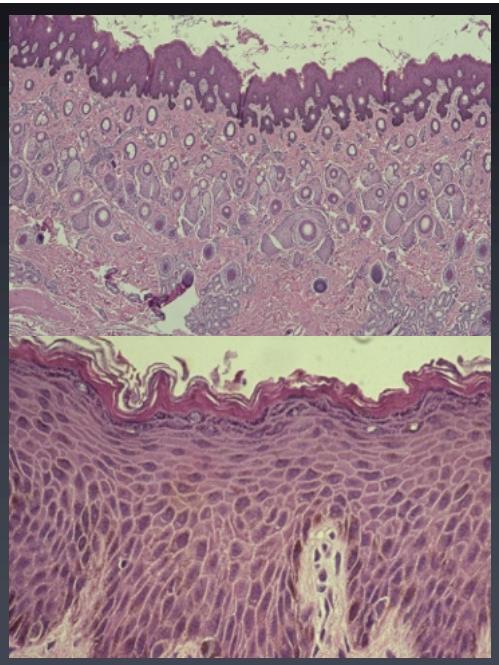
Epidermis

Dermis

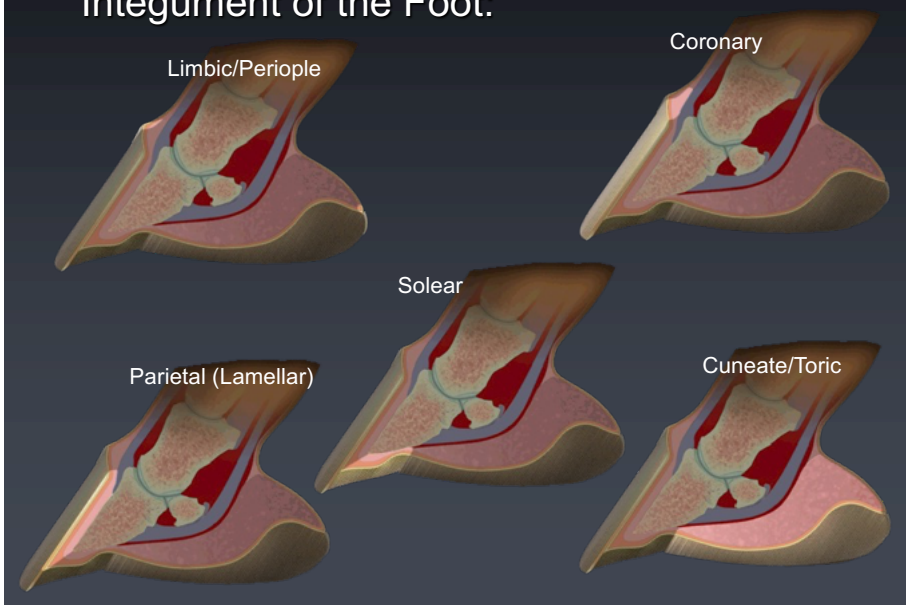
Subcutaneous Tissue

Cornified Layer

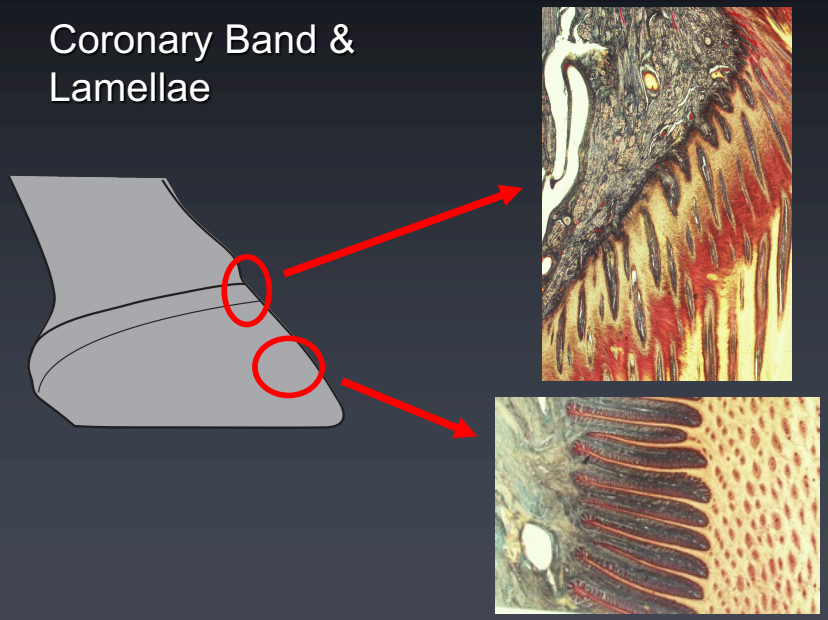
Germinal Layer

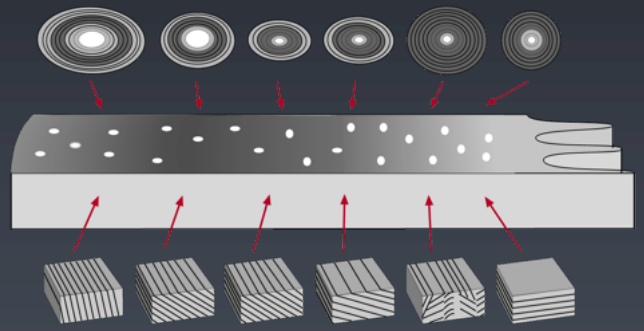


Integument of the Foot:

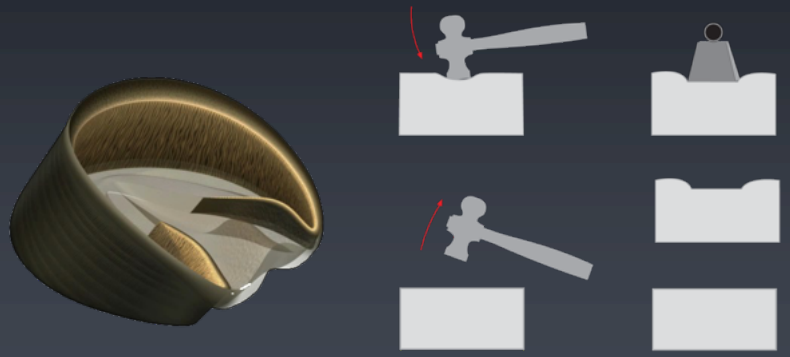


Coronary Band & Lamellae



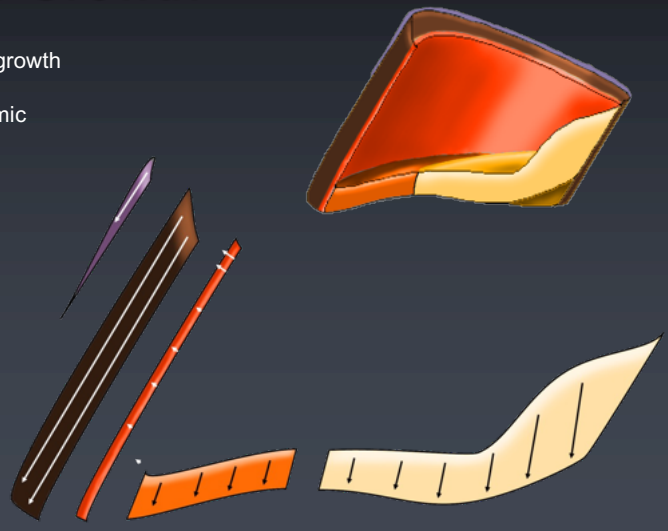


Viscoelasticity and the Hoof Wall



Hoof Growth

Pattern of growth
Factors
- Systemic
- Local



But if I was a betting person …

Wang and Li *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology* 2010, **2**:16
http://www.smarttjournal.com/content/2/1/16

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REVIEW **Open Access**

Mechanics rules cell biology

James HC Wang*[1] and Bin Li[2,3]

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On the biomechanics and mechanobiology of growing skin

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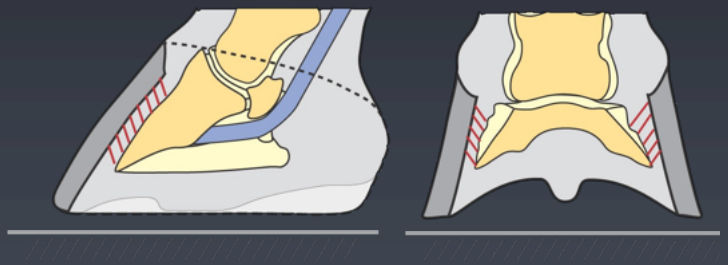
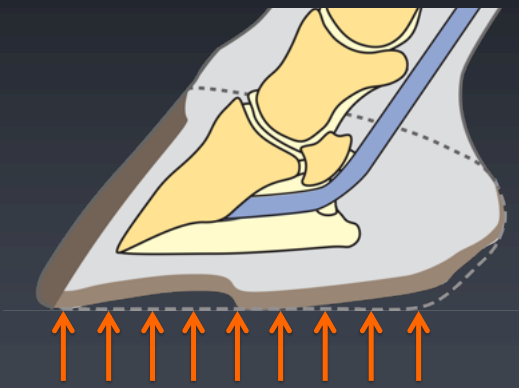
Biomechanics of the Distal Limb: Key Concepts

- Distribution of Pressure
- Ground Reaction Force
- Center of Pressure
- Moment or Torque

Our starting point: the distal phalanx (P3) is suspended in the foot by the lamellae

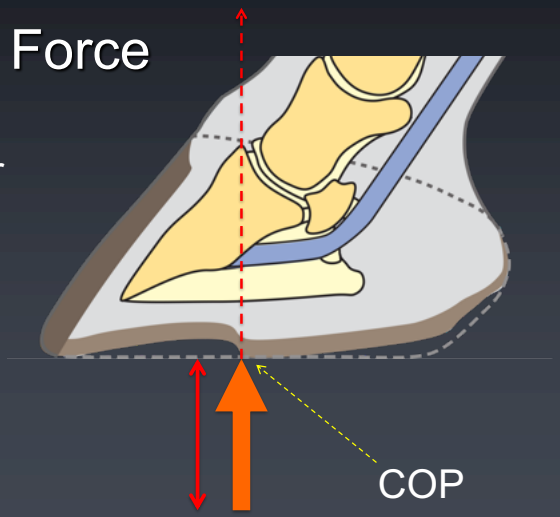


Ground Contact

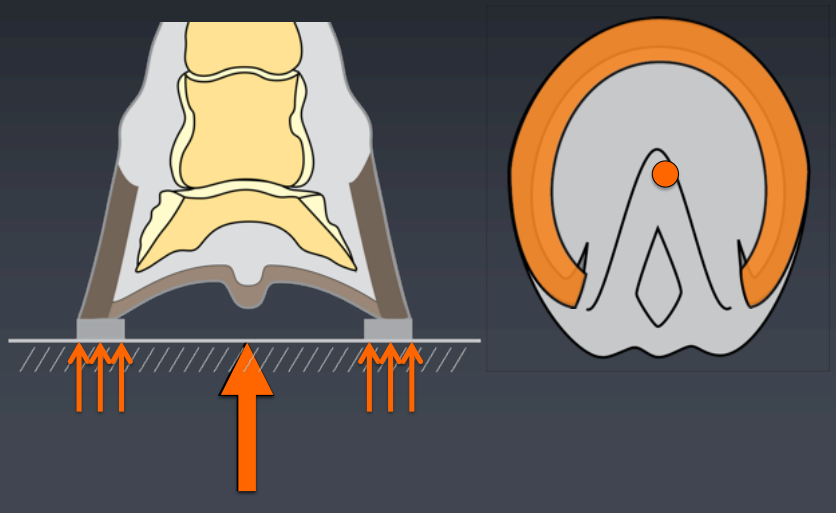


Ground Reaction Force

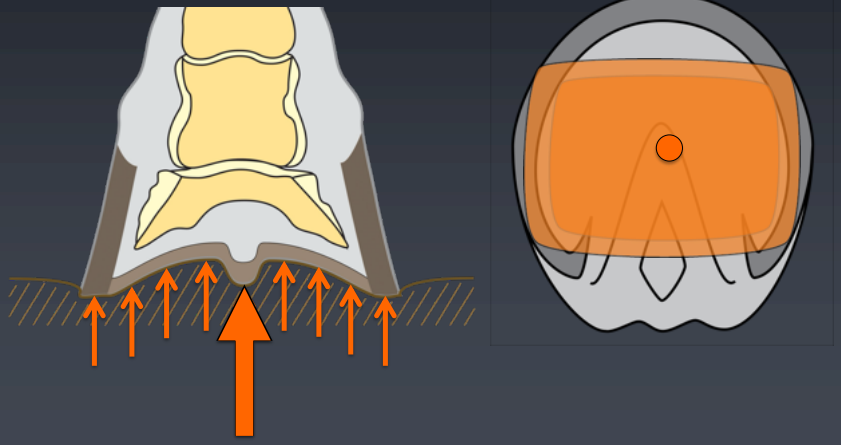
GRF = Vector



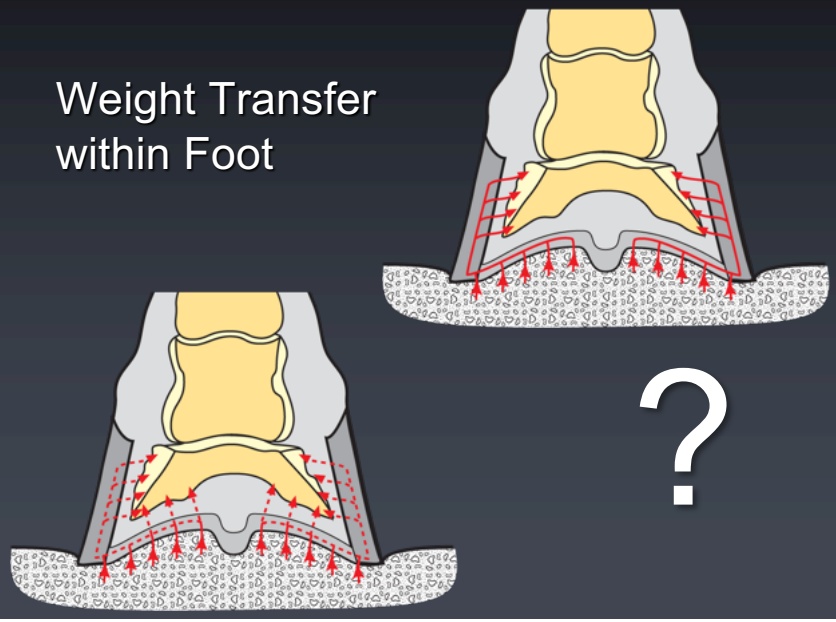
Shod / Flat surface



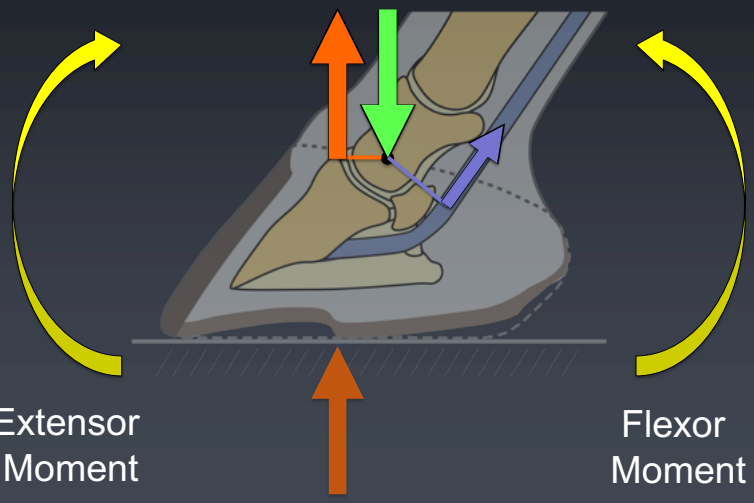
Barefoot / Deformable surface

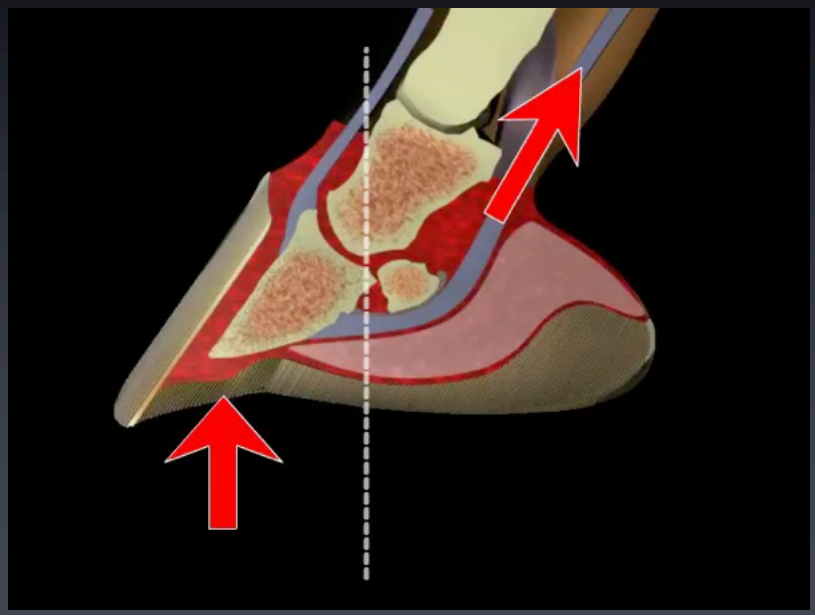


Weight Transfer within Foot

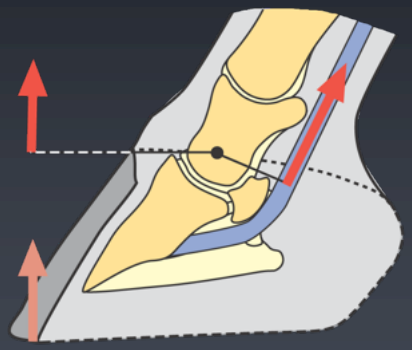


GRF x Extensor MA = Tendon Force X Flexor MA



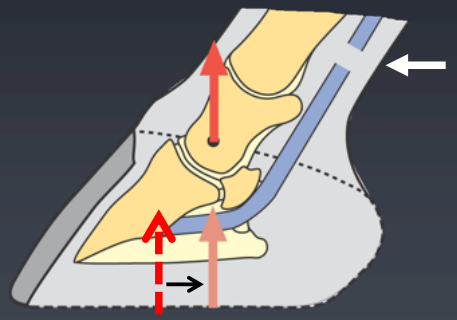


Moments about the DIPJ at Rest in Disease States



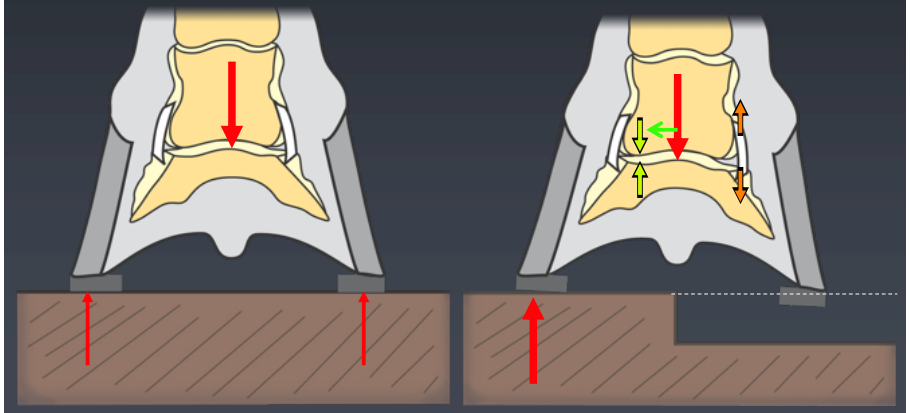
Flexural Deformity
(Caused by increased
DDF tension)

Moments about the DIPJ at Rest in Disease States

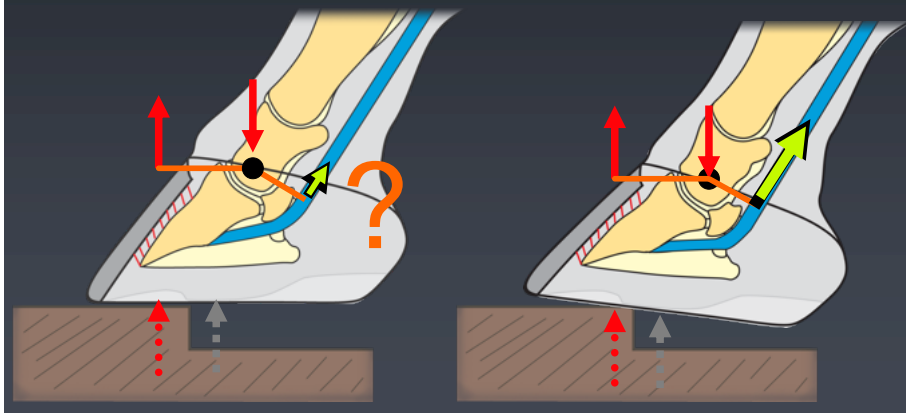


Severed DDF
(Caused by decreased
DDF tension)

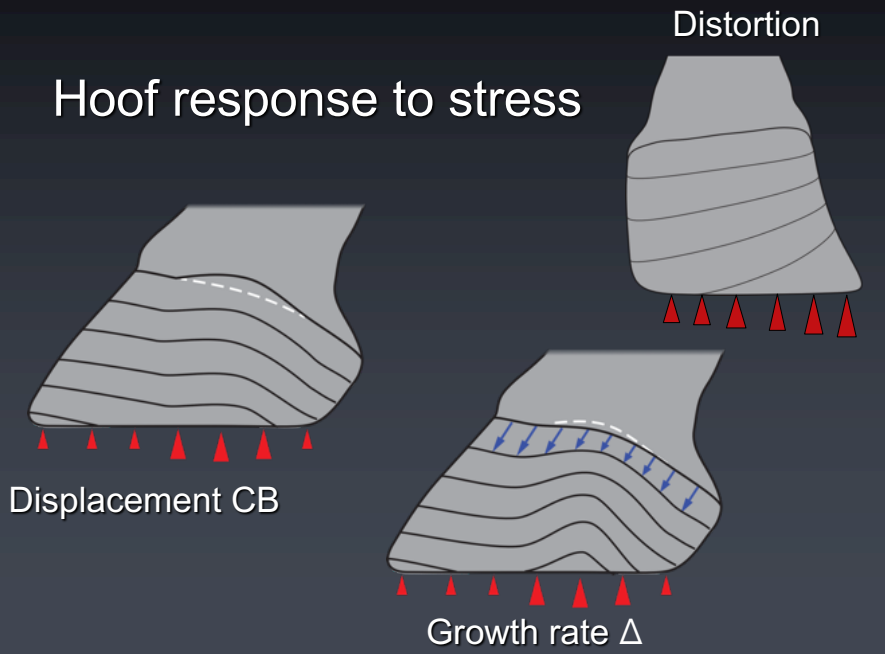
Thought Experiment: ML



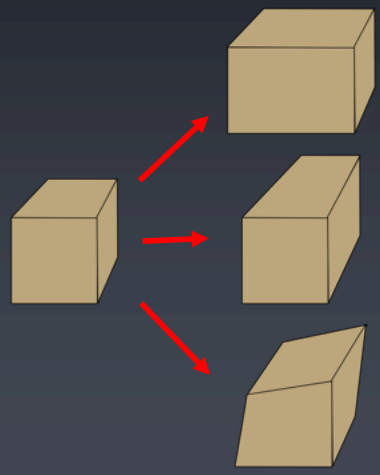
Thought Experiment: DP



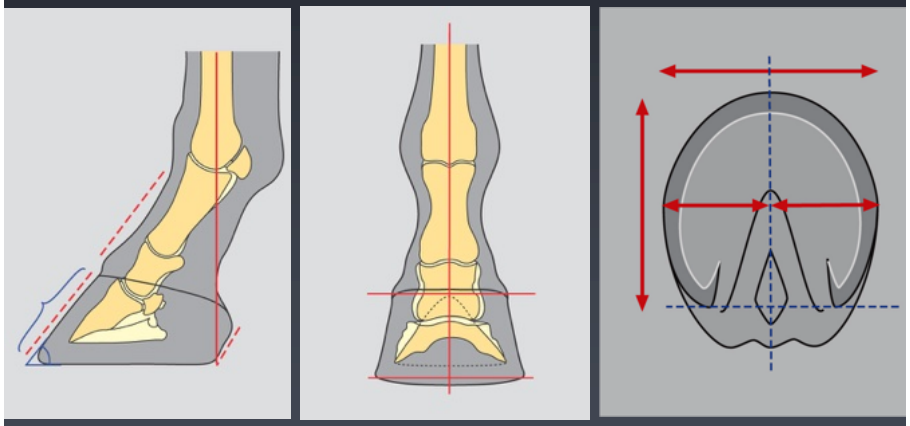
Hoof response to stress

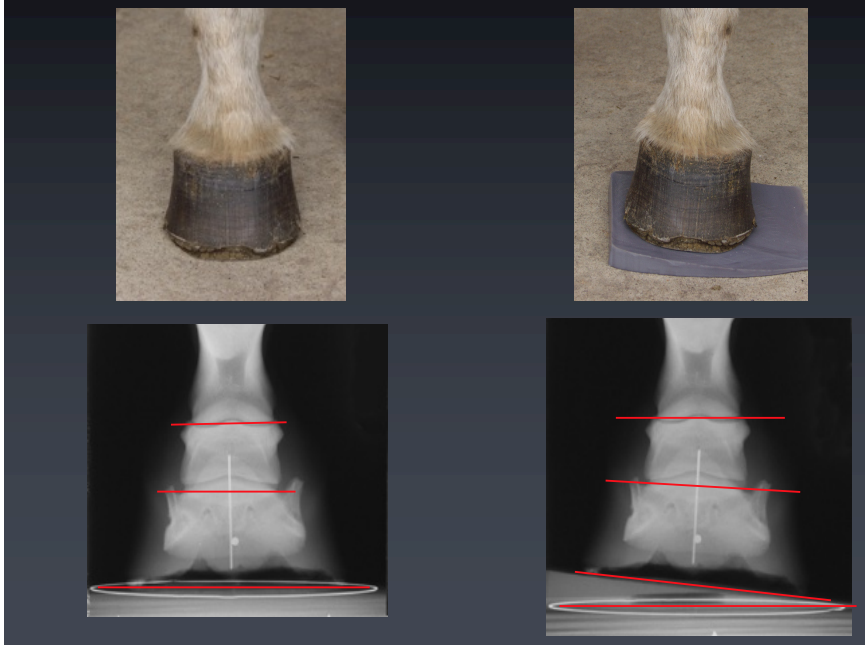


The Foot as a Box

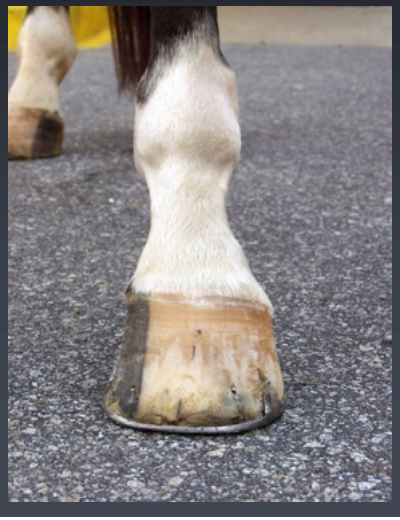


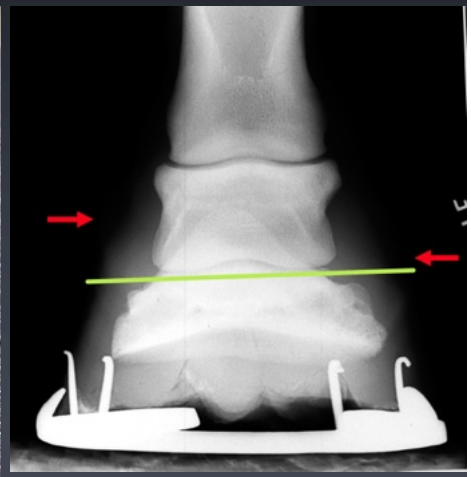
Effect of Shape on Function

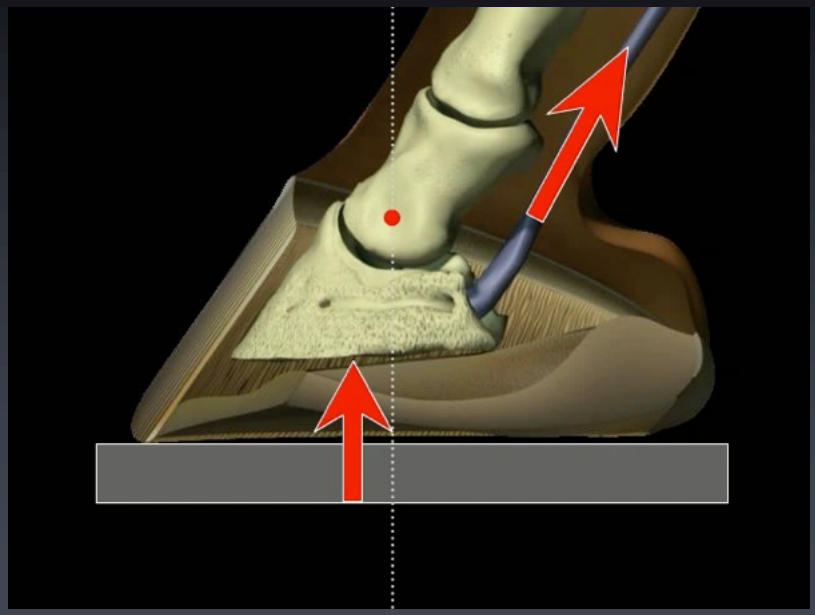




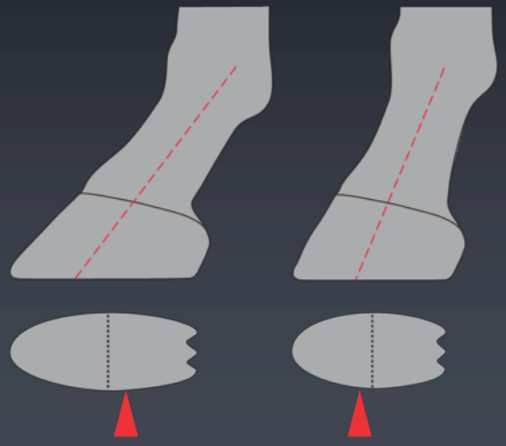
Chronic M/L Evaluation: Radiographic Evidence (or lack of)



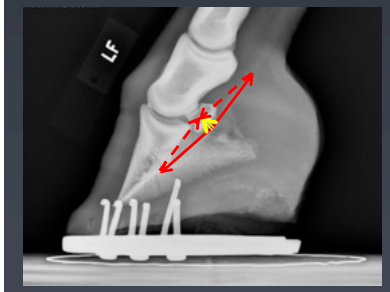


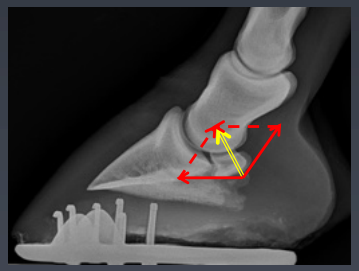


Effect of Conformation: Pastern Angle



Effect of Foot Pastern Axis





Physical Exam: Types of Information

Leads to a diagnosis	→	Specific treatment
Indicators of abnormal stresses	→	Symptomatic treatment
Predisposition to disease	→	Preventive care

What are you looking for?

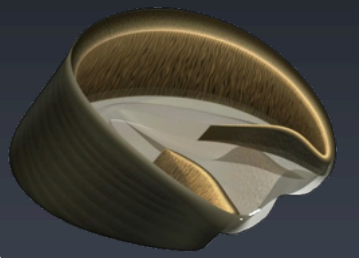
Most Diseases Associated with Inflammation

- Pain
- Swelling
- Heat
- Discoloration
- Change in function

Acute vs. Chronic

What Makes the Foot Different?

- Hoof capsule rigidity: limits swelling
  - Difficult to detect
  - Magnifies pain
- Hoof viscoelasticity: change in shape
- Hoof growth: change rate, surface and shape



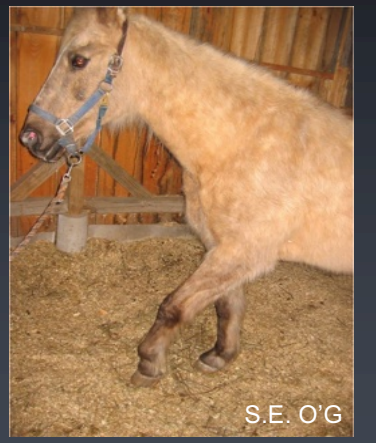
Clinical Evaluation of the Foot: History

- Presenting complaint
  - Lameness / appearance
- Onset: rapidity and severity
- Duration: time and variation
- Treatment and effect
- Effect of rest or exercise
- Shoeing: frequency, changes, last

Look at the whole horse first

Body condition

Stance



Examination of the Foot: A Breakdown

I. Basic examination of the foot

II. Examination in relation to the rest of the limb

III. More detailed examination of hoof morphology

IV. Evaluation of the limb in motion

V. Evaluation of shoeing

I. Basic Examination of the Foot

1. Assess appearance
2. Palpation
3. Manipulation
4. Compression and Percussion
5. Paring

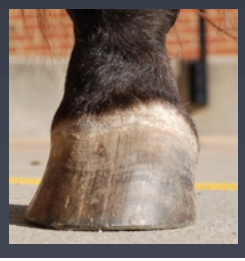
1. Appearance

Hoof trauma
- Single event
- Repetitive stress

Texture and coloration of surface

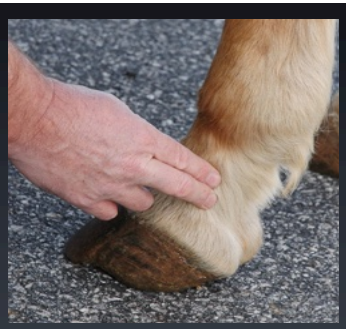
Distortion of hoof capsule

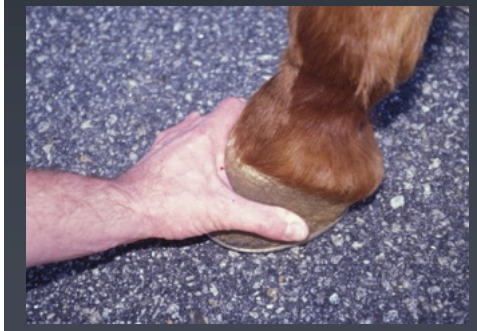
Swellings proximal to coronary band

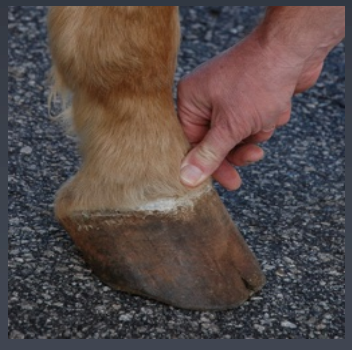


2. Palpation

Temperature and digital pulse

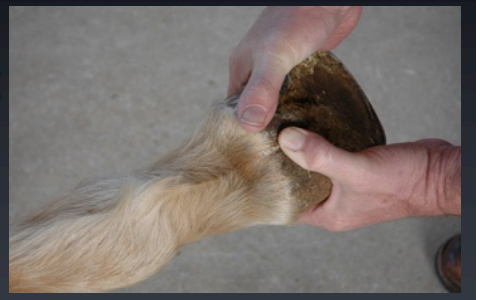


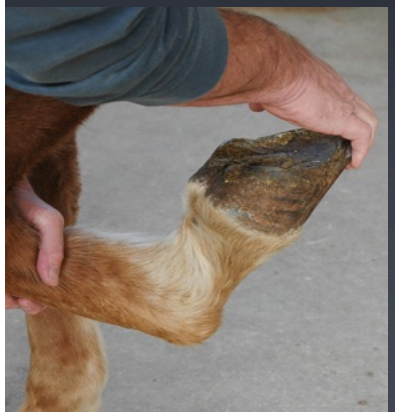




3. Manipulation:

Flexion and rotation





4. Compression and Percussion

Pain

Express fluid

Movement of hoof

Expose occult cracks

Individual variation

Be systematic

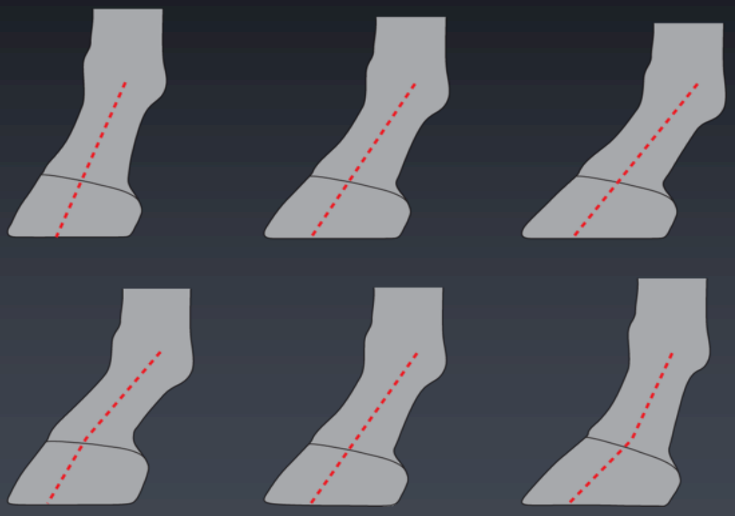
5. Paring/Exploring

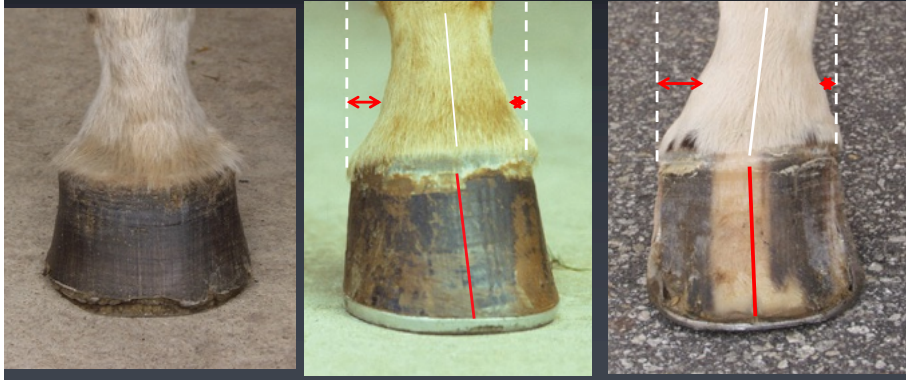
Depends on History

Remove shoes

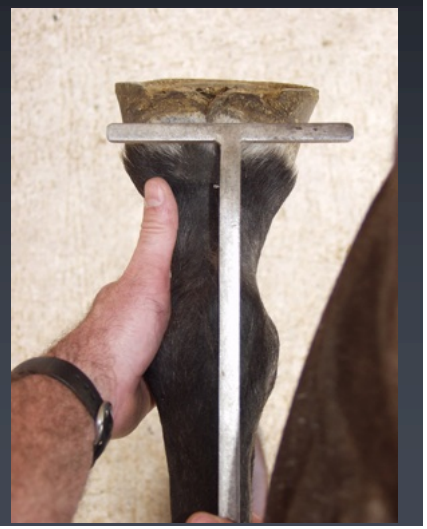
II. Examination of the Foot in Relation to the Rest of the Limb

- On the ground
  - Dorsal, lateral, and palmar perspective
- Off the ground
  - Dorsal, palmar and solar perspective

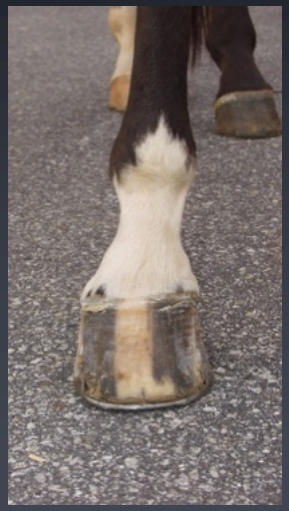


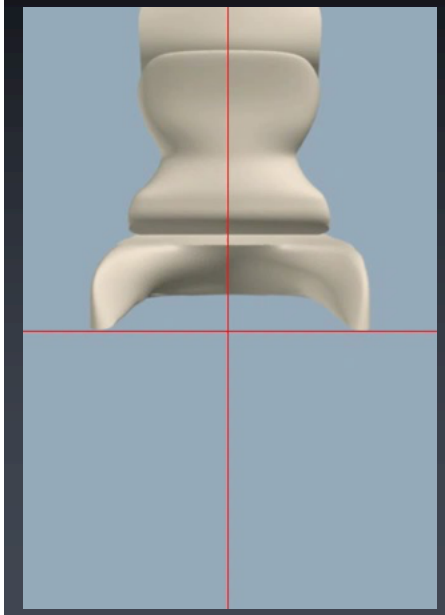


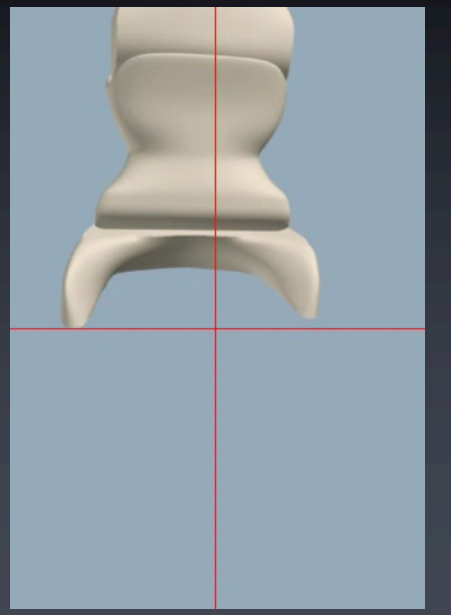
T-Square



T-Square





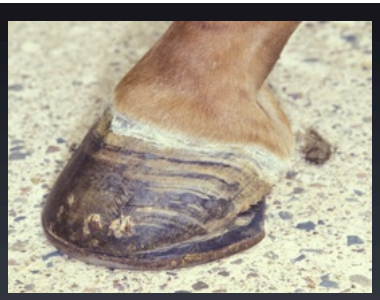


III. Examination of Hoof Morphology

- Size
- Shape
- Growth pattern
- Local distortion
- From 4 perspectives

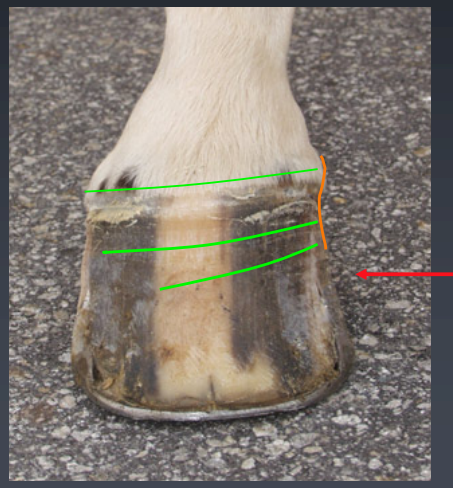
Size and Shape

Lateral Perspective

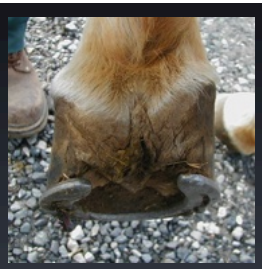


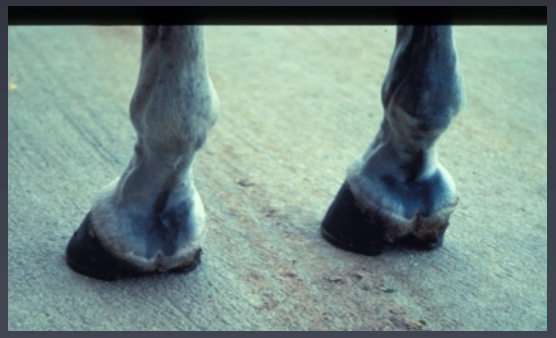
Eliashar, 2004

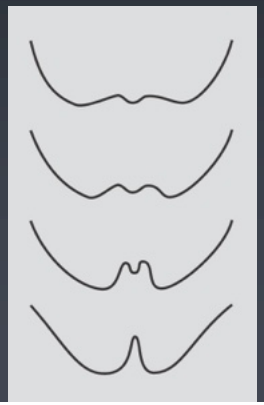
Dorsal Perspective



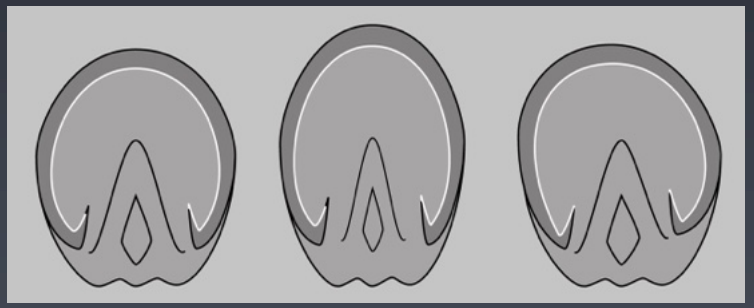
Palmar Perspective







Solar Perspective

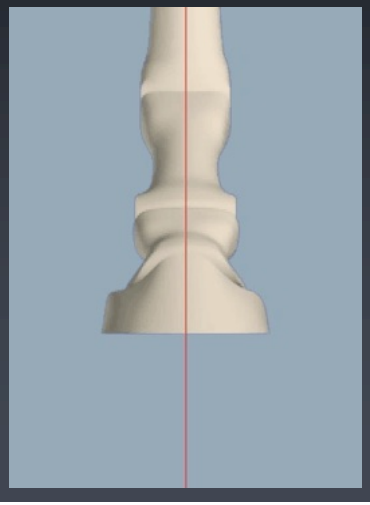


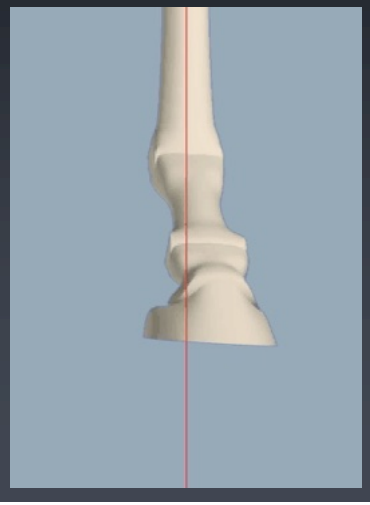
IV. Examination of The Foot in Motion

Pattern of Landing

- Normal - lateral heel/quarter first or flat at walk
- Changes with pain due to: change in stride length avoidance increase duration of impact

Observation of limb in flight phase





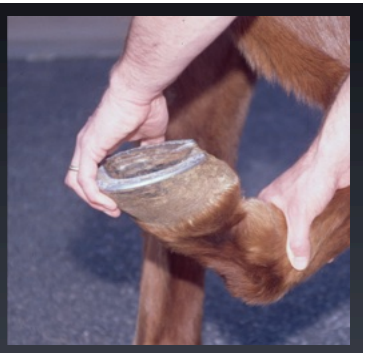
Stress Tests

Affect structures associated with Motion

Flexion test

- Sound horses often flex positive
- Individual clinician consistency
- Between clinician variability
- Repetition increases response

Extension test

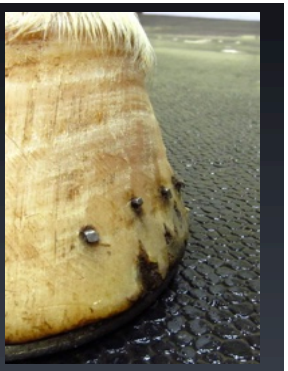


V. Examination of Shoes

Shoe Fit

Shoeing interval

Shoe wear



6

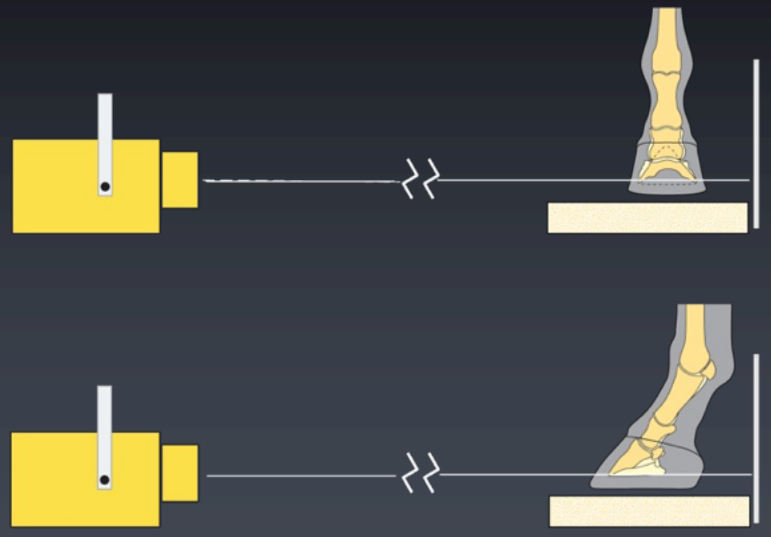
If I have time!

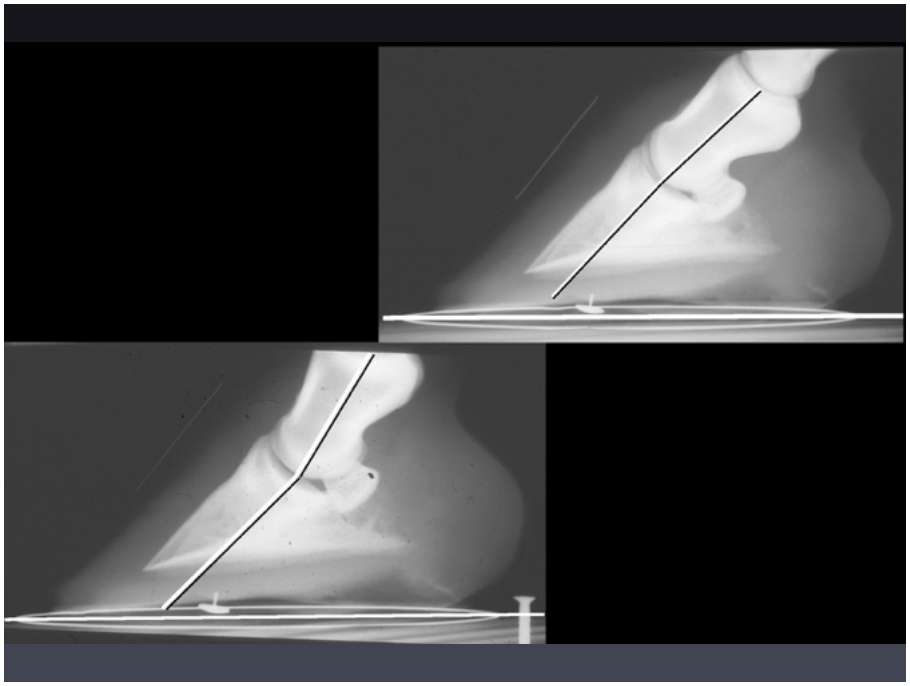
Radiology: Relationship between hoof and DP

- Size and shape of hoof
- Relationship of the hoof to the distal phalanx
- Relationship between the phalanges

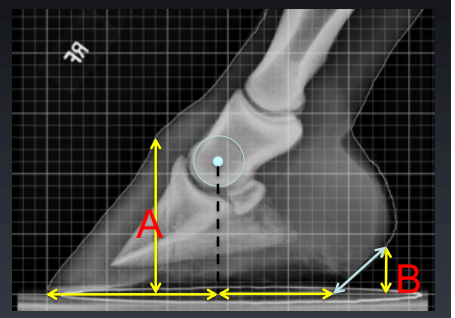
- Even weight bearing
- Flat surface

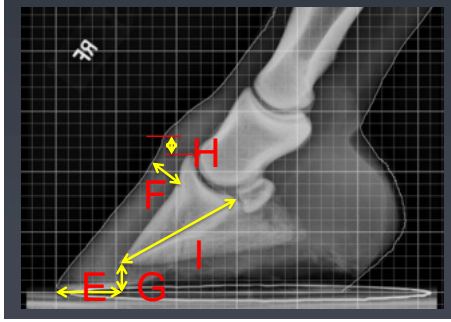
- Careful alignment
- No forced rotation
- Toe, sole (frog) markers

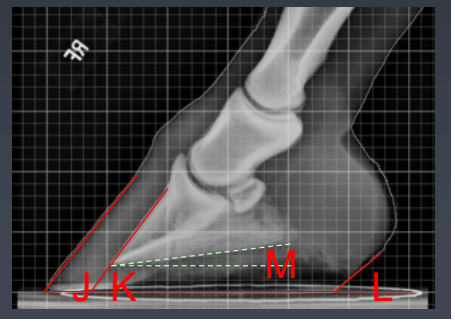


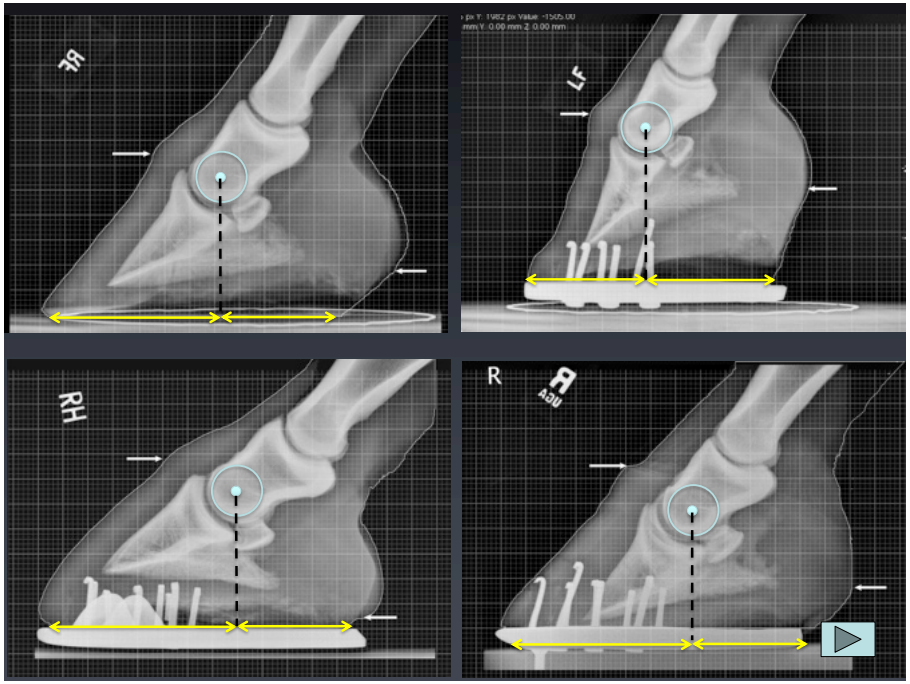


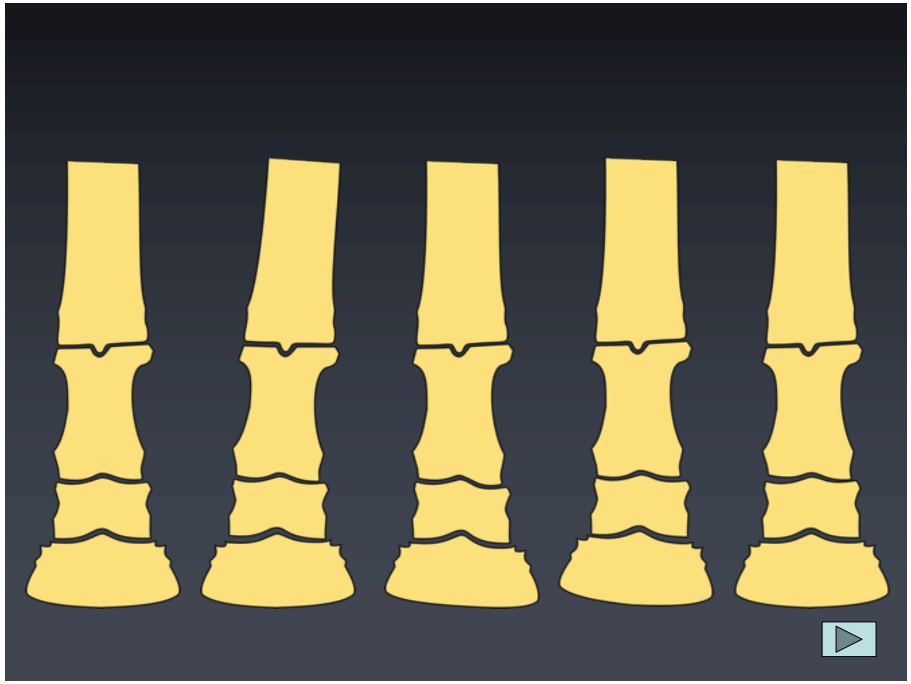
The relationship between capsule and distal phalanx: A class exercise











“Normal” Dorsopalmar

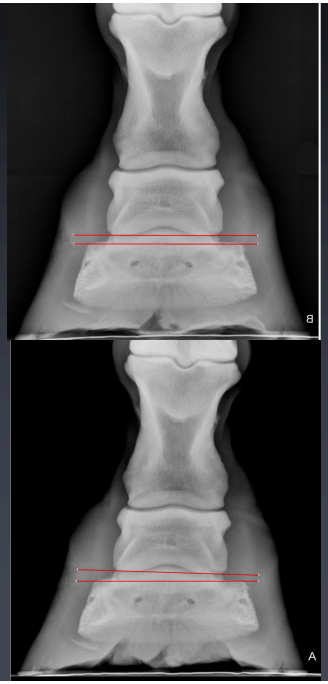
- Vertical MC III
- Even joint spaces
- DP horizontal
- Symmetry
  - M vs. L hoof

Normal Variant

- Vertical MC III
- Joint spaces
  - Even
  - Not horizontal
- DP not horizontal

Positioning Artifact

- MC III
  - angled
- Uneven joint spaces
- Compression same side

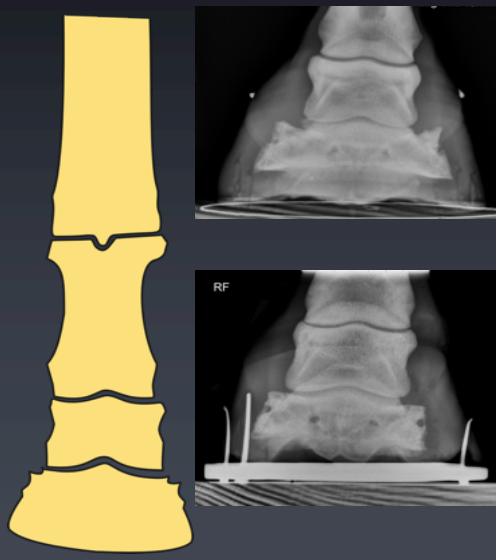


Unilateral Joint Compression

- MC III vertical
- Single joint uneven
- +/- second joint uneven opposite side
- = Cartilage loss

Bilateral Joint Compression

- MC III vertical
- DIP and PIP compressed same side
- Asymmetry of M & L walls
- Asymm laminitis/ WLD?



Conclusion

- How the foot is “constructed” including conformation and balance influence digital biomechanics and response to stress
- Digital biomechanics influences the distribution of stress in structures of the limb
- Distribution of stress influences the shape and alignment of the foot which can be detected on a physical exam
- Identifying abnormal patterns or stress distribution and understanding digital biomechanics can inform decisions regarding therapeutic farriery